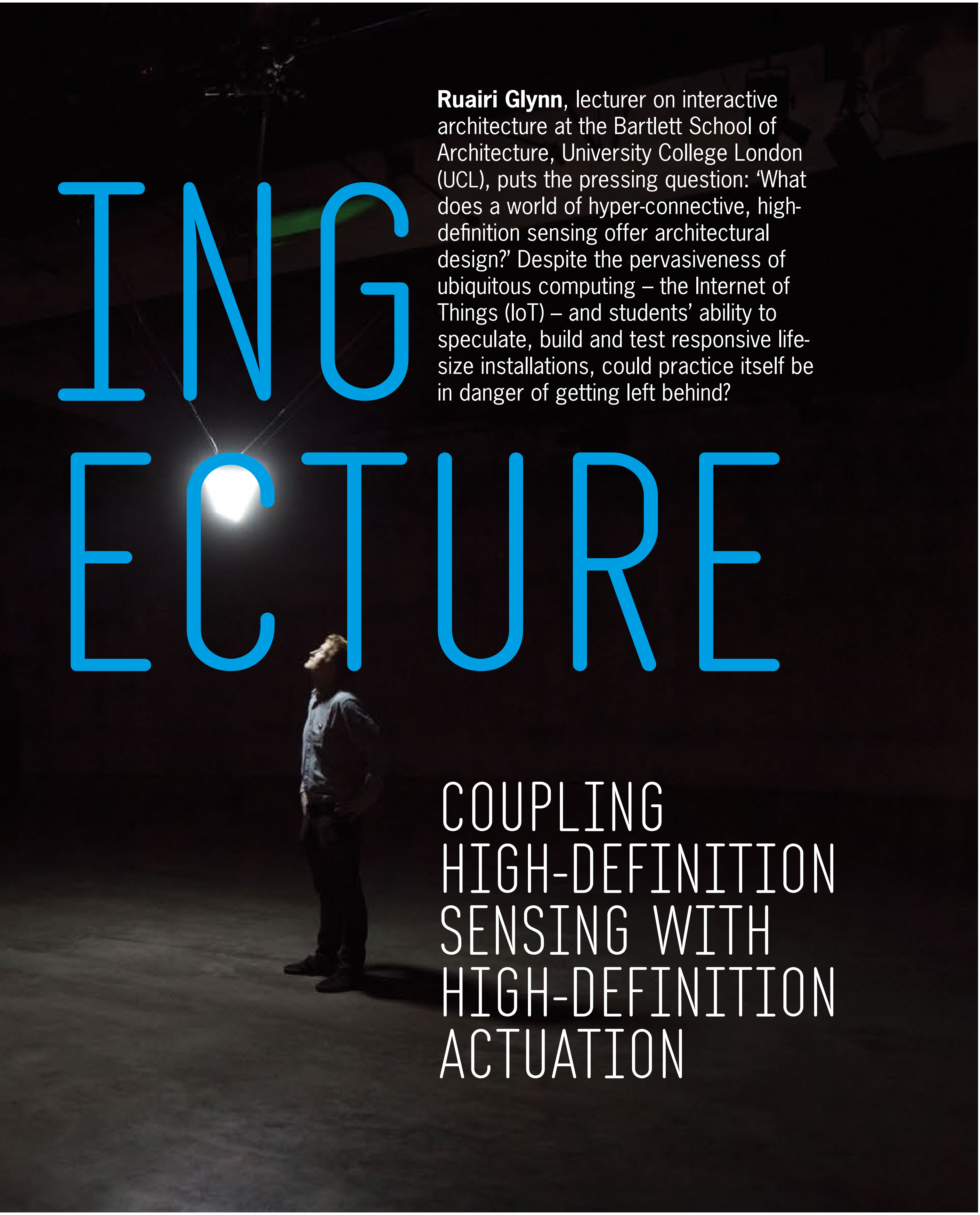
Ruairi Glynn

ANIMAT ARCHIT

Ruairi Glynn, *Fearful Symmetry*, The Tanks, Tate Modern, London, 2012
Hidden up above in the darkness, like a long string marionette puppeteer, the autonomous delta robot manipulates the motion of the luminaire beneath it.



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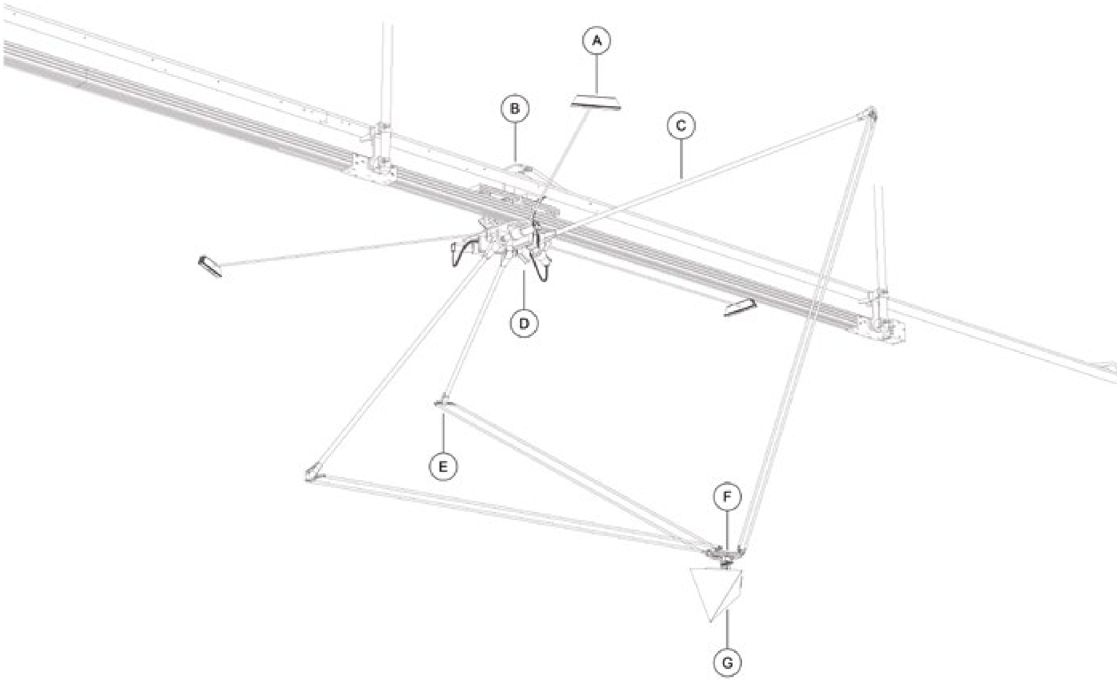
ECTURE

Ruairi Glynn, lecturer on interactive architecture at the Bartlett School of Architecture, University College London (UCL), puts the pressing question: 'What does a world of hyper-connective, high-definition sensing offer architectural design?' Despite the pervasiveness of ubiquitous computing – the Internet of Things (IoT) – and students' ability to speculate, build and test responsive life-size installations, could practice itself be in danger of getting left behind?

COUPLING HIGH-DEFINITION SENSING WITH HIGH-DEFINITION ACTUATION



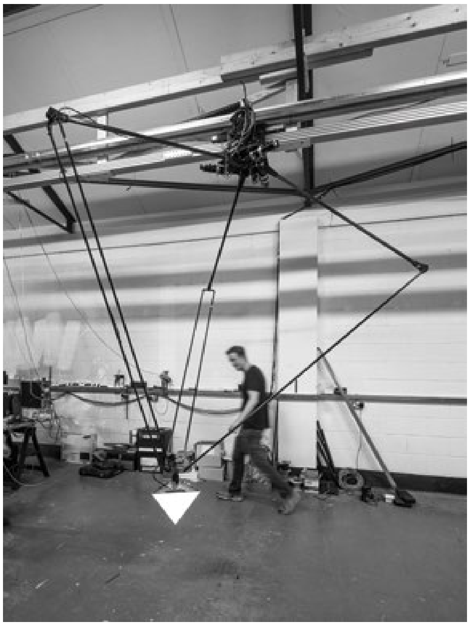
Annotated illustration of the 5-metre (16-foot) tall custom-built delta robot: (a) Kinect sensor array; (b) 21-metre (69-foot) linear carriage; (c) carbon-fibre structure; (d) central robotics platform; (e) parallel mechanism; (f) pan and tilt servomotors; (g) electroluminescent tetrahedron.

Harnessing live sensor feeds, social media, maps, and a deluge of datasets gathered by networked devices and distant servers, context-aware computing is changing our means of engagement and occupation of the city. But this appears to be just the tip of an iceberg. Internet-enabled devices are bifurcating, promising to do to our buildings what they have done to our cities. Virtually every corner of product and service design is investing itself in ubiquitous computing, the Internet of Things (IoT) (see Andrew Hudson-Smith's article on pp 40–47) – call it what you will. If it lives up to its evangelists' promises, we should expect embedded sensing and computing to saturate our homes and workplaces. Billions of active devices building dense, rich layers of real-time sensor data where even our own clothes may monitor our biodata to share with the 'cloud'. These vast datasets, latent with novel applications for consumers and industry alike, beg the question: What does a world of hyper-connective, high-definition sensing offer architectural design?

Looking to today's schools of architecture you find, with surprising abundance, students literate in Internet protocols and scripting, hacking together electronics, and programming microcontrollers. What started in a few experimental studios has spread globally, catalysed by the open-source hardware revolution. Affordable and accessible technologies are encouraging students not only to speculate, but to build and test responsive installations at 1:1 scale. Ecological and conversational models of communication and adaptation are pushing design thinking beyond reactive paradigms and towards truly interactive environments. After decades of speculation and prototyping within academia, the technologies to practically realise sensor-rich buildings capable of adapting to inhabitant activity, responsive to individual needs and surrounding conditions are becoming accessible. The path to their broader adoption, however, is far from clear.

Looking to practice, the response to the emerging IoT has been cautiously slow. While the building industry might acknowledge its potential to change the built environment profoundly, it has resisted taking a leading role in its arrival. As William Gibson once remarked: 'The future is already here – it's just not evenly distributed.'[1] And from all early indications, it is consumer markets that will build this smart infrastructure – architects and building engineers will be largely bypassed while they continue to follow established holistic approaches to so-called 'smart' or 'intelligent' buildings.

Rendered view looking up. A central robotics platform actuates three carbon-fibre armatures that descend down to collaboratively puppeteer its end effector – a glowing electroluminescent tetrahedron that appears to float in the air while the robot hides in the darkness above.



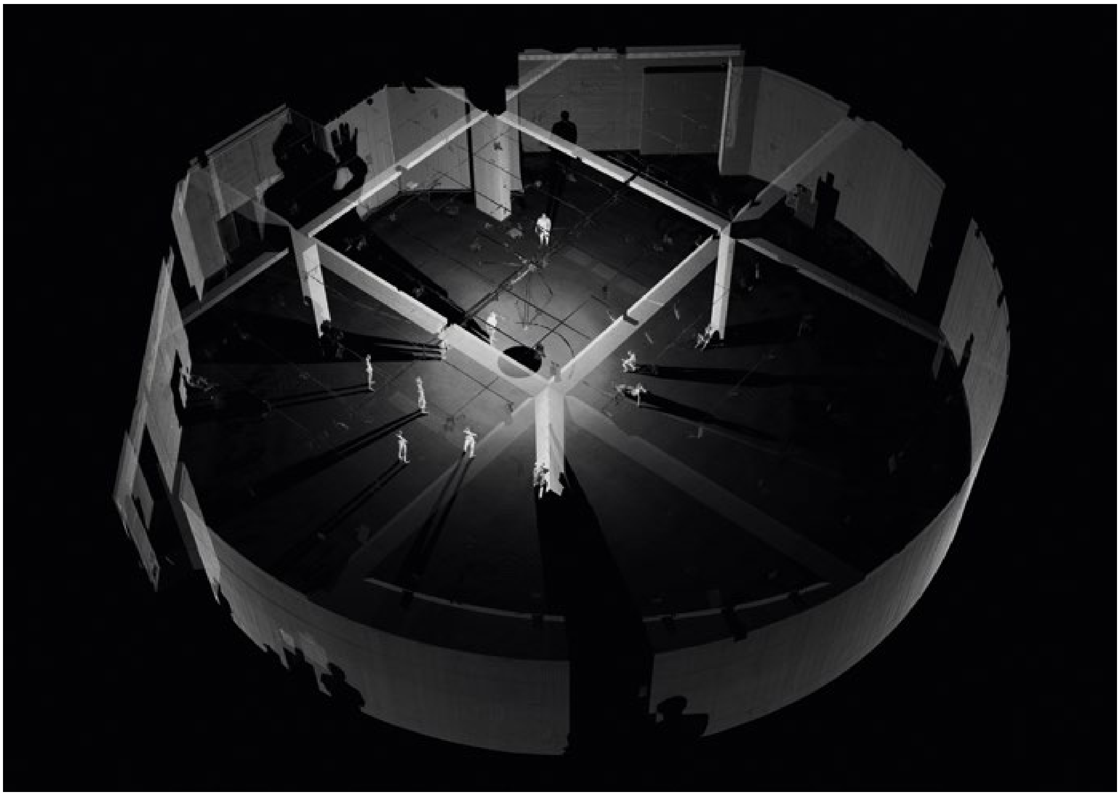
Ruairi Glynn, *Fearful Symmetry* out of the shadows, London, 2012
Ruairi Glynn walks by his custom-built machine at his Walthamstow workshop, revealing the scale of the world's largest delta robot.

Elaborating on the age-old thermostat model, current approaches incorporate sensing, computation and actuation within the fabric of the building. For a variety of reasons, not least, mitigating risk, holistic approaches are generally based on closed proprietary systems – good at dealing with well-defined domains such as room temperature or light levels, but not so good at dealing with unpredictable domains like human behaviour, changes in programme and in surrounding climatic, social and economic conditions. Over the lifespan of a building, this inflexibility ultimately results in human control being either constrained or an illusion altogether.[2]

IoT offers a very different approach principally built on open-source protocols. Sensor networks, built ad hoc, are flexible regarding relocation and replacement – growing over time as cost, accessibility and services improve and expand. As ubiquitous sensing and computation gradually infiltrate, building data densifies and diversifies. Machine learning algorithms running on remote servers collect and make sense of these complex interconnections, feeding back into the environment through available local actuation. As these open connective platforms grow, designers and communities develop new applications. The result – a dense, self-organising computational field permeating material and spatial practices, from textile, product and service design to furniture, landscape and architecture.

These two approaches to building responsive architecture are worlds apart. The holistic top-down model, rigid and reductive but complete and predictable. The IoT bottom-up model, intangible and bewildering to many, but adaptable and extendable. One trend emerging in the automation industry is a turn towards open-source hardware platforms as they prove their robustness. This may well offer the convergence point between these approaches. Of course predicting future technology adoption can be perilous for even the best-informed observer, but if, as IoT evangelists suggest, sensor networks get built and distributed informally over time, with distant servers making sense of the growing datasets, then sensing and computation will have been largely lifted from the responsibility of the architect and building engineer. The key role remaining in this scenario will be to 'close the loop' – designing the forms of actuation that feed back into the built environment.

With the diversity of actuation technologies expanding almost as fast as sensing, a fertile territory is opening up. As robotic applications for the built environment bifurcate, space is becoming increasingly motive – from fine-scale, micro-actuated composite materials to



Ruairi Glynn, ***Fearful Symmetry*, The Tanks, Tate Modern, London, 2012**
above and opposite: Elevation and perspectival views of lidar scans (by ScanLAB Projects) within the Tanks at Tate Modern. Scans capture the shadows cast across the floor and walls of the Tanks as the public gather round.

adaptive building facades; from autonomous ground and air vehicles to all forms of virtual agency in augmented-reality landscapes. As the resolution with which buildings detect and interpret human behaviour increases, we can anticipate sophisticated reciprocal gestures from our built environment as delicate and deliberate as those made by its inhabitants. Through the coupling of high-definition sensing and actuation, space will become ever more animate, perceptively possessing a life of its own, populated with agency, in constant conversation with its surroundings.

Fearful Symmetry

Exploring the perception of life or 'anima' in form and space, *Fearful Symmetry* was commissioned by Tate Modern for the 'Undercurrent' programme inaugurating its new 'live art' space, the Tanks.[3] The cavernous concrete chamber of the south tank, 32 metres (105 feet) in diameter and 7 metres (23 feet) tall, had previously lain dormant for decades, cloaked in darkness. The response to the site was a living luminaire revealing the dramatic space as it moved around the gallery interacting with the visiting public. Primitive in appearance, to avoid figuratively inferring life, a piercing glowing tetrahedron glided through the air, swooping down to play with visitors and fleeing up and away if too many got close. Taking its title from William Blake's 'The Tyger',[4] the installation intended to create a visceral state of hyper-awareness in the public as they encountered the intimidating dark chamber and the strange life-form that inhabited it.

Hidden up above in the darkness, like a long string marionette puppeteer, a 5-metre (16-foot) tall autonomous delta robot, custom built to manipulate the motion of the luminaire beneath it, moved back and forth through the space on a 21-metre (69-foot) motorised rail. An array of Kinect sensors mounted on the travelling robot built a real-time 3D point cloud of its local environment, detecting the public and reading their individual movements using gesture-recognition algorithms. Reciprocally, the agile performer responded with behaviours choreographed with the collaboration of a team of puppeteers, giving the machine its uncannily human character.

Encouraging the public to suspend their disbelief and play with the living luminaire, the more people engaged gesturally with the work, the more enthusiastic its responses would be. If visitors were stationary it would hover over them, slowly turning mechanically and abstractly, almost mocking their inanimateness. With the subtlest change from mechanical to smooth fluid motion, the

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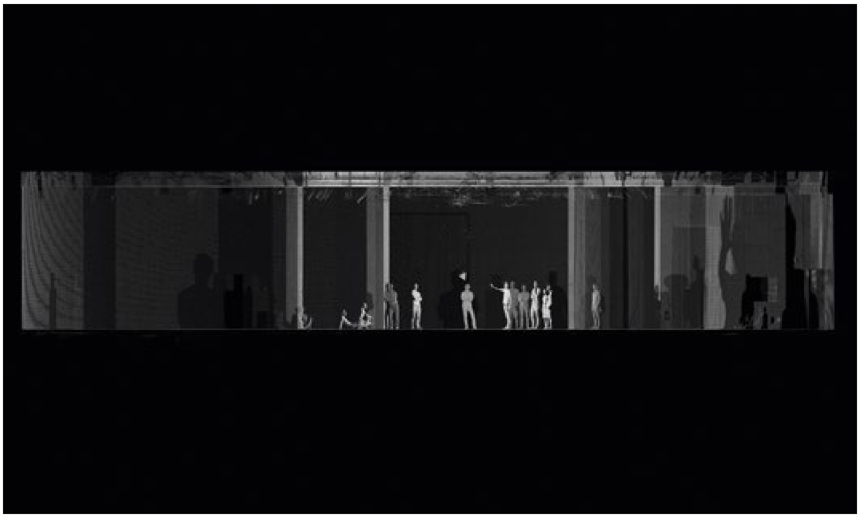

work transformed from a lifeless platonic solid to a living breathing performer. Precise motion control of the delta robot manipulator was critical, but far more important was creating the perception that the movements were purposeful. With sophisticated analysis of the public's gestures, the autonomous robot reciprocated with a perceptible intelligence and emotion. While at first intimidating to visitors of the Tanks, many of the public became increasingly comfortable and confident in performing with their luminous companion as their exchanges developed.

Two decades ago at the dawn of the World Wide Web, Kevin Kelly proclaimed that:

> The central act of the coming era is to connect everything to everything. All matter, big and small, will be linked into vast webs of networks at many levels. Without grand meshes there is no life, intelligence, and evolution; with networks there are all of these and more.[5]

Today, the Internet of Things appears to be at the dawn of its realisation. Will we find ourselves two decades from now sharing a built environment teeming in animate forms of intelligence and synthetic life? While contemporary architectural research in robotics has focused on its potential for digital fabrication applications, there is another rich territory of interaction that deserves greater attention – one offering architects exciting opportunities to build aesthetically potent environments[6] that will profoundly change our relationship and engagement with architecture. AD

Notes

1. William Gibson, quoted in *The Economist*, 4 December 2003.
2. Jared Sandberg, 'Employees Only Think They Control Thermostat', *Wall Street Journal*, 15 January 2003: http://online.wsj.com/article/SB1042577628591401304.html.
3. The design and fabrication of *Fearful Symmetry* was made possible with the generous support of the Bartlett School of Architecture, University College London (UCL), the department of Product Design Engineering, Middlesex University, and the Centre for Robotics Research, King's College London: see www.fsymmetry.com/.
4. Published as part of Blake's collection of poems, *Songs of Innocence and Experience*, 1794. Tate Publishing; Facsimile edition, 2 October 2006, p 40.
5. Kevin Kelly, *Out of Control: The New Biology of Machines*, Perseus Books (New York), 1994, p 173.
6. Gordon Pask, 'A Comment, a Case History and a Plan', in Jasia Reichardt (ed), *Cybernetics, Art and Ideas*, Studio Vista (London), 1971, pp 76–99. In the article Pask discusses the properties of aesthetically potent environments, 'of environments designed to encourage or foster the type of interaction which is (by hypothesis) pleasurable'.